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DISEASES OF FIELD CROPS IN OKLAHOMA

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Diseases of Field Crops in Oklahoma

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Diseases of wheat, oats, corn, barley, and cotton have been conservatively estimated as causing an annual average loss of 25 million dollars to Oklahoma growers. Diseases of field legumes cause additional serious losses. *Most of these diseases can be prevented by simple and inexpensive practices.*

The following tables and discussion tell how to recognize the principal diseases of fields crops, and give brief instructions for preventing them. Bulletins and circulars telling more about some of these field crop disease problems are listed on pages 23 and 23.

Free service in identifying diseased specimens and prescribing control measures is provided by the Department of Plant Pathology at the Oklahoma Agricultural Experiment Station. Information on how to submit specimens is given in Okla. Agri. Exp. Sta. Mimeographed Circular M-42.

THE COVER: A greatly enlarged picture of a section of an old corn stalk carrying black masses of countless fungous spores. These spores enable one of the corn stalk rots to survive and spread. Stalk and root rots of corn and sorghum number among the most destructive field crop diseases in Oklahoma.

DISEASES AFFECTING SPECIFIC CROPS ALFALFA

Disease	Identification	Prevention
Leaf Spots	Dead areas of various sizes and shapes on orange, then black fungous pustules. Leaves bodies. Early loss of infected leaves.	Mow a little more frequently than in ordinary practice, to salvage as many leaves as possible. Continuous premature mowing for long periods will shorten the life of the stand but leaf diseases are highly destructive only in occasional seasons, during which premature mowing could be safely practiced.
Rust	Brown, powdery rust spore masses on leaves, which fall prematurely.	
Bacterial Wilt	In second year or later, plants become stunted and die. A crosscut of the stem at the soil line shows a yellowed ring, under the bark, which slips off easily. Laboratory identification may be required.	Do not reseed alfalfa on land where the crop has failed from wilt, until old roots have decayed. Varieties Ranger, Hardistan. Orestan, Ladak, Cossack, and Buffalo have some resistance.* Use winter-hardy strains of alfalfa. Avoid spreading on the mower blades. Do not cut or pasture alfalfa late in the fall.
Texas Root Rot	See page 15.	
Dodder	Patches of yellow, tangled vines overrunning and killing alfalfa.	Mow, dry, and burn the dodder vines. Use only good seed, free from dodder seed.

* Under wilt-free conditions, common alfalfa will usually outyield wilt-resistant varieties, but once wilt is present in a field the adapted wilt-resistant varieties will usually survive longer and be more profitable than Common strains.

BARLEY

Disease	Identification	Prevention
Smuts	Heads transformed into dark brown or black, dusty spore masses, exposed or partly covered by glumes, blowing away or remaining in the head.	Seed treatment with Ceresan will prevent most barley smut. Where some smut remains after Ceresan treatment (brown loose smut) the hot water treatment may be required (see page 20 or it may be preferable to obtain new, smut-free, certified seed.
Rusts	Leaves, or more rarely stems, with powdery orange, then black fungous pustules. Leaves prematurely killed, yields and quality reduced.	Manchuria barley is resistant to leaf rust. Stem rust is not usually destructive in Oklahoma. Breeding for increased rust resistance is in progress.
Powdery Mildew	Leaves with a white, powdery fungous coating, dying prematurely. Not a major disease.	Tenkow and Manchuria barleys show some resistance, and numerous other resistant varieties are being tested.
Bacterial Blight	Leaves with many irregular-shaped spots, light tan with a reddish-brown border. Leaves killed prematurely.	Not often destructive. Some varieties such as Wisconsin Winter appear to be highly resistant to the disease. Avoid seed from diseased crops. Crop rotation.
Spot Blotch and Net Blotch	Leaves with chocolate-brown, oval or elongated spots, uniform or with a ladder-like vein pattern in the centers of the spots.	Not usually serious. Manchuria has resistance to spot blotch. Practice seed treatment, thorough, early plowing, and crop rotation.
Stripe	In plants before heading, yellow streaks on leaves, turning brown, with plants killed before or soon after heading.	Treating seed with Ceresan as for smut will prevent stripe.
Seedling Blight; Poor Stands; Damping-Off	Poor stands or seedlings dying after coming up, or weak development with dark areas on stem bases and roots.	Seed treatment with Ceresan, Arasan, or Spergon offers some protection. Of these, only Ceresan is also effective against smuts and stripe.

CORN

Disease	Identification	Prevention
Seedling Root Rots or Seedling Blight	Poor stands obtained, especially from early plantings. Seedlings light green to yellowish in color; may wilt and die.	Avoid early planting; treat seed with dust as directed on page 17. Obtain seed of highest quality possible.
Macrophomina Dry Rot. ("Charcoal Rot")	Plants mature early; leaves turn slaty-gray color, become dry and brittle; stalks lodge early and easily; ears droop too early in season, and are lightweight in comparison to ears on healthy stalks. Lower portion of stem hollowed out; vascular bundles covered with black spots the size of pin points.	Cultural practices that encourage vigorous growth of the crop will reduce the disease. See discussion on page 16.
Smut	Smut first appears on ears, stalks, leaves and/or tassels as hard, somewhat greenish; shiny boils. The boils develop into large, black, dusty, smutty masses. Boils especially destructive on ears. Large boils on stalks tend to result in barrenness or lightweight ears or nubbins.	No good control measures known. Seed treatment is ineffective. Field sanitation (removal of boils from field or plowing them under) and crop rotation probably of value in lessening severity of disease.
Root, Stalk and Ear Rots	Various fungi (red, yellow, green and black molds) cause rotting of cobs and kernels. Also attack stalks and roots of plants. Ear rots following ear worm damage. Vitality and germinability of seed reduced; market value lowered and yields reduced.	Obtain seed of highest quality possible. Treat seed with dust as directed on page 17. Practice field sanitation and crop rotation.
Rust	Light-brown to reddish-orange oblong lesions formed on leaves; later becoming dark brown. "Skin" of leaves broken and rough.	Disease of minor importance; no control measures necessary.
Brown Spot	Yellowish to brown to dark-brown colored spots found on leaf sheaths, stalks and base of leaf blades. Later in season, spots rupture and produce rough, scaly, rusty appearance.	Disease of minor importance except occasionally severe in low, wet fields. Where necessary, field sanitation and crop rotation aid in keeping disease to minimum.
Stewart's Disease or Bacterial Wilt	Striping of leaves, with some wilting and stunted plants when disease is severe. Sel-dom occurs on field corn.	No control measures necessary.
Helminthosporium	Elongated, bleached-out spots and some-	No control measures necessary in

COTTON

Disease	Identification	Prevention
Bacterial Blight or Angular Leaf Spot and Boll Rot	Small, irregular and angular watersoaked spots in the leaves; later becoming black; veins often brown to black. Defoliation occurs in severe cases. Spots on bolls round, at first greenish and watersoaked, later brown to black and depressed. Lint sticks to locks of boll. Often followed by fungous boll rot.	Treatment of seed with 1 to 1½ oz. New Improved Ceresan per bu. will delay disease and reduce losses; 2 to 3 year rotation with any other crops gives good relief.
Seedling Diseases and Damping-Off	Brown sunken areas appear on stems at soil level and below; plants wilt and frequently die. Plants recovering are usually stunted. A principal cause of poor stands.	Treat seed with New Improved Ceresan as for bacterial blight. Attacks are associated with cold, wet weather.
Fusarium Wilt	Plants are stunted, leaves yellowish. Disease frequently occurs in irregular spots in the field. Plants often die prematurely. Fresh cuts across the stems near the ground level of wilted plants show a ring of brown or black discolored wood.	Disease is associated with light, sandy soil deficient in potash. Use high potash fertilizer. Use 3-year rotation. Inquire at the Agricultural Experiment Station about resistant varieties.
Verticillium Wilt	Symptoms are similar to those of "Fusarium wilt." Cut stems show minute specks of grayish-green color throughout the wood.	No suitable control known. Rotation with legumes will help reduce infection. Disease occurs principally on heavy soils.
"Rust"	First symptoms in form of yellow to brown mottling of leaves; leaves die at margins, curl up and finally fall at about time bolls begin to open. Plants usually die.	Disease is caused by a deficiency of potash. Apply potash as suggested under "Fusarium Wilt."
Root Knot	See page 15.	
Texas Root Rot	See page 15.	

COWPEAS

Disease	Identification	Prevention
Bacterial Canker	Large, open, brown or black wounds in main stems, killing the plant, with serious yield reduction.	Use seed from disease-free fields and practice crop rotation. The more resistant varieties include Victor, Buff or Iron, Speckled Crowder, Potomac or Calico, Brown or Sugar Crowder, White Browneye Crowder, Brabham, New Era, and Groit.
Mosaic	Leaves mottled light and dark green, puckered, stunted. Poor yields.	Use seed from disease-free fields. Varieties Cream Crowder, Red Ripper, Taylor, Iron, and Black are less susceptible than others.
Rust	Brown, powdery rust spore masses on leaves.	Rarely abundant enough to warrant control measures.
Macrophomina Dry Rot ("Charcoal Rot")	Premature death with stems hollowed, dotted inside with tiny black fungous bodies.	Practices to encourage vigorous growth of cowpeas. See page 16.
Poor Stands; Damping-Off; Seedling Disease	Poor stands. Weak or dying seedlings with dark disease lesions at stem bases or on roots.	Treat seed with Arasan or Spergon, which will not interfere with nodulation.
Root Knot ("Nematode")	Roots with many large and small swellings that eventually decay, involving the whole thickness of the root. Not lateral and healthy as nodules.	Crop rotation (See page 15). Varieties Iron, Brabham, Victor, Monetta, Conch, and two Texas selections of Black Eye are resistant to root knot.
Texas Root Rot	See page 15.	

FLAX

Disease	Identification	Prevention
Wilt and Seedling Blight	Plants turn yellow or grayish and growth stops; plants die, often suddenly, with ashy-gray root decay, and stem rot.	Plant wilt resistant Redwing, or, if good seed is available, Bison instead of such susceptible varieties as Linota. Rotate flax with other crops.
Rust	Light yellow, reddish-yellow, and finally black, buried rust spots on leaves, stems, and seed bolls.	Plant rust resistant varieties such as Viking, Walsh, Rio, Bolley Golden, and Buda where rust is a problem.
Pasmo Disease	Leaves, stems, and bolls are blighted with light or dark brown circular blotches, dotted with tiny fungous fruiting bodies.	Treat seed as indicated below and practice crop rotation. Bison and Buda are less susceptible than some other varieties.
Poor Stands; Seedling Blight; Damping-Off	Poor stands or seedlings dying after coming up, or weak development with dark areas in stem bases and roots.	Treat seed with Ceresan, Arasan, or Spergon, $\frac{1}{2}$ ounce per bushel.
Heat Cankers	Plants dying from effects of dead zone at soil line, due to action of heat from direct sun.	Run rows north and south, not east and west. Plant early enough to have the plants shade one another before hot weather. Avoid thin sowing rates.

PASTURE GRASSES

Disease	Identification	Prevention
Ergot	Black, banana-shaped horns replace grains. These are highly poisonous to livestock and cause death of many Oklahoma cattle.	Cut for hay before ergot horns form. Avoid feeding ergoty hay. Graze bottomland early and heavily to keep grasses from maturing. Remove livestock from infested pasture, or supply clean forage during fall and winter when heads are softened by moisture and other forage is covered with snow.
Rusts	Red or orange, then black, dusty, spore masses on leaves and stems.	No control possible in native pastures. (Note: Rusted grasses are not poisonous, and may be rather rich sources of protein.)

OATS

Disease	Identification	Prevention
Crown Rust (Leaf Rust)	Oval, bright, salmon-orange, powdery rust spots mainly on the leaves and leaf sheaths, followed by black covered rust pustules. Leaves are killed prematurely, reducing yields seriously.	Seed treatment is not effective. Rust resistant or escaping varieties for fall planting: Fultex, Ranger, Rustler, Red Rustproof group, Hastings Hundred Bushel, Appler, New Nortex, Ferguson 922, Wintok; for spring planting: Tama, Boone, Fultex, Kanota, Fulghum (708), Columbia, Victorgrain.
Stem Rust (Black Rust)	Longer, brick red rust pustules, mainly on stems, tearing away the "skin" of the stem, followed by black, open rust pustules.	Usually develops too late to be very destructive in Oklahoma. The oats varieties listed above are also resistant to stem rust.
Smuts	Spikelets transformed into black, powdery masses of smut spores, partly covered by the glumes or exposed, blowing away.	Easily prevented by treating seed oats with Ceresan or formaldehyde. See pages 17 to 20.
Seedling Blight; Poor Stands; Damping-Off	Poor stands or seedling 'dying after coming up, or weak development with dark areas on stem bases and roots.	Seed treatment with Ceresan offers some insurance against this condition. Formaldehyde is not effective. Spergon and Arasan dusts are effective against this condition, but not against smut. See page 17.
Anthracnose and Septoria Leaf Blotch	Dead, tan, fairly large leaf spots dotted with tiny tufts of fungus or small black fungous fruiting bodies. Leaves die from the spots outward.	Usually not very serious. Crop rotation and early, thorough plowing are aids in reducing these diseases.
Blast or Sterility	White, empty spikelets at a time when normal spikelets are green. Due to unfavorable growing conditions, especially wet weather at time of pollination.	No control known beyond cultural practices designed to secure as normal growth of the crop as possible.

PEANUTS

Disease	Identification	Prevention
Leaf Spot	Fairly large, round, dead spots on leaves, causing leaves to fall prematurely.	Ordinarily not severe enough to warrant control. Dusting crop with sulphur, where disease is severe, is a paying practice.
Poor Stands; Damping-Off; Seedling Blight	Poor stands, or seedlings wilting and dying with dark disease lesions on stem bases and roots.	Seed dusting with Arasan or Spergon is recommended as a standard practice in Oklahoma.
Root Rots except Texas Root Rot	Weak plant development, premature death, more or less decay in lower part of stem and roots.	Crop rotation; cultural practices to encourage vigorous growth.
Texas Root Rot	See page 15.	

RYE

Disease	Identification	Prevention
Leaf and Stem Rusts	Orange, yellow, or red powdery rust pustules on leaves or stems, followed by black rust pustules.	Stem rust not common enough to require control measures. Leaf rust sometimes injurious, but development of resistant varieties still in an early stage.
Stem Smut	Black stripes on leaves and stems, bursting to release black powdery smut spores. Plants are dwarfed, and heads may fail to emerge from boot.	So uncommon that no preventive measures are ordinarily necessary. If required, seed treatment, crop rotation, and destruction of stubble and straw from infested crops, provide control.
Leaf Blotch	Oblong, well-defined dead spots on leaves and leaf sheaths.	Crop rotation and sanitation if control required, which is unusual.

SORGHUMS

Disease	Identification	Prevention
Kernel Smut	A large percentage of the kernels of grain in a diseased head are transformed into smut balls which are filled with sooty black spores. Smut balls are eventually broken open, giving a powdery black appearance to the entire head.	Seed treatment with one of the following: (a) Ceresan— $\frac{1}{2}$ oz. per bu. (b) 50% Copper Carbonate—2 oz. per bu. (c) Spergon—1 oz. per bu. See instructions on page 17.
Milo Disease	Plants appear unthrifty, lower leaves turn yellow as plant slowly dies. A few plants may produce small heads. May be confused with drought or chinch bug injury. However plants suffering from this disease have a characteristic brick-red coloration of the crown of the plant.	Use resistant varieties. At present resistant strains of most of the standard varieties are available. If in doubt consult your county agent or the Agricultural Experiment Station.
Macrophomina Dry Rot ("Charcoal Rot")	Diseased plants are characterized by earlier maturity and a pronounced tendency to break over at or near the ground level (lodging). Within the hollow lower stem are many small black specks clustered over the shredded remains of the onetime solid stem.	Be sure seed bed is properly prepared. Don't plant during cool weather. Use seed treatment as indicated for kernel smut. Cultural practices that encourage vigorous sorghum growth will reduce the disease. Development of disease-resistant sorghum varieties is under way. See further discussion on page 16.
Rust	Numerous, raised, red to purplish pustules on under side of leaves. Pustules about $\frac{1}{8}$ inch in diameter filled with a rusty spore mass at maturity.	Control measures usually unnecessary. Some varieties, particularly milos and milo hybrids, are resistant to rust.
Anthracnose	Produces numerous spots on leaves of broomcorn, grain and sweet sorghums. Spots vary from $\frac{1}{8}$ to $\frac{1}{2}$ inch in diameter. They are brick red at first but soon turn brown with several black or gray specks in center. In broomcorn the disease also attacks the roots and stem, frequently causing lodging.	No effective control known. Seed treatment and crop rotation help. Some varieties are more resistant than others, e. g. the grain sorghums Spur feterita and shallu, and the sweet sorghums Atlas, McLean, Folger, Denton, Planter, Straightneck, Silvertop, Cowper, Hodo, C. P. Special, Leoti, and Georgia Blue Ribbon.
Bacterial Leaf Spots	The most common sorghum disease. Causes numerous irregularly-shaped, small or large spots and streaks on the leaves. Spots at first red but later turn brown. Tips of diseased leaves turn brown and the lower leaves may be entirely killed.	Disposal of old crop litter, crop rotation, and seed treatment will help control. The sorghos are more susceptible than the grain sorghums. Leoti sorgo, Cody (Waxy Club), shallu, and Tift and Sweet Sudan grasses are resistant.

SOYBEANS

Disease	Identification	Prevention
Bacterial Blight; Bacterial Pustule	Angular yellow, brown or black leaf spots, that may join to make large dead patches, or drop out, making leaf ragged. Leaves fall prematurely. Plants weakened, with poor yields.	Testing, in progress, shows some difference in susceptibility of soybean varieties. The variety Ogden, which is recommended for Oklahoma, shows some resistance to the disease.
Mosaic	Leaves mottled green and yellow or pale green, puckered, stunted; yields poor.	Avoid seed from infested fields. (Certified seed is a safeguard.)
Pod and Stem Blight	Dead areas on stems and pods, dotted conspicuously with black, fungous fruiting bodies. Premature death of plants.	Sanitation, use of disease-free seed, crop rotation. A dangerous disease.
Macrophomina Dry Rot ("Charcoal Rot")	Plants die prematurely, often in well-defined spots in the field. Hollow stems dotted inside with tiny black fungous bodies.	Cultural practices to increase vigor of growth of the crop. See page 16.
Root Knot ("Nematode")	Roots with many large and small swellings that eventually decay, involving the whole thickness of the root; not lateral and healthy as nodules.	Crop rotation (see page 16). The variety Laredo, which is recommended in Oklahoma, is resistant. See page 15.
Poor Stands; Damping-Off; Seedling Blight	Poor stands; seedlings wilting and dying, with dark disease lesions on stem bases and roots.	Treat seed, especially that of low germination, with Arasan or Spergon, which will not interfere with nodulation.
Texas Root Rot	See page 15.	

WHEAT

Disease	Identification	Prevention
Leaf Rust or Red Rust	Reddish-orange, dusty spore powder on leaves, followed by dying of the leaves. With severe, early attack yields are reduced and grain is light. This is the most destructive wheat disease in Oklahoma.	Use rust-resistant wheat varieties. Comanche and Pawnee are new, semi-resistant, hard wheat varieties worthy of trial. New, Oklahoma-bred, rust-resistant varieties are expected to be available, beginning in 1947.
Stem Rust or Black Rust	Powdery dark red, then black streaks, mainly on stems. Not usually damaging enough to require special control measures in Oklahoma.	No special measures usually necessary. Some leaf rust resistant wheat varieties also have resistance to stem rust.
Bunt or Covered Smut or Stinking Smut	At harvest time, grains found to be transformed into smut balls, filled with black, foul-smelling spore powder. Smutty wheat is docked in price.	Treat seed wheat with New Improved "Ceresan" dust as directed on page 17.
Loose Smut or Blackheads	Heads, at blossoming time, degenerated into black, powdery spore masses that blow away, leaving inconspicuous naked stems.	Use certified seed, or seed known to have come from smut-free fields, or treat seed with hot water as directed on page 20.
Dry Land Foot, Rot or Root Rot	Plants die in spots in the field at any time, but especially as the crop approaches ripening. Base of stem discolored; roots decayed; heads may be white and empty or overgrown with black molds; grain often shrivelled.	Avoid planting before the date recommended for your part of the State. Use the best agronomic practices for building up vigor in the crop. Plant only well-adapted wheat varieties. Phosphate fertilization is beneficial where moisture conditions permit its use.
Speckled Leaf Blotch	Leaves in late fall, winter, and early spring with brown, dead patches, speckled with tiny black fungous fruiting bodies, then dying. Often confused with winter injury.	No control measures known. Attempts are being made to develop resistant wheat varieties.

DISEASES AFFECTING MANY CROPS

Texas Root Rot

Texas root rot or cotton root rot in Oklahoma is confined to the counties bordering on the Red River, and in some cases extending up into the next tier of counties. It is a major problem in growing cotton and field legumes in this area.

The disease may be recognized by widespread dying of plants from July onward. The roots of affected plants are decayed, and on the surface of main roots may be found khaki-colored strands of fungous threads which identify the disease.

Texas root rot often appears in large, well-defined spots in the field, and it is sometimes confused with lightning injury or alkali spots. It can be distinguished from alkali spots by the fact that the plants appear to make excellent growth until they suddenly die, whereas plants in a highly alkaline soil are stunted before they die.

The disease attacks cotton and most summer legumes. It is not a serious problem in winter legumes such as vetch and Austrian winter peas because the disease is active only in summer months. All cereals and grass crops are resistant to root rot.

Root rot is caused by a fungus which lives for many years in the soil. Where soil is infested, susceptible summer crops cannot be grown continuously with any success. This disease is controlled by practicing 4-year rotation in which susceptible crops are grown only one year out of the four. The other three years the land may be used for any grain or grass crop. Winter legumes may be used in the rotation if they are harvested or turned under by June. Wherever feasible, practices to increase the amount of organic material in the soil tend to reduce root rot damage.

Root Knot or Nematode Disease

Like Texas root rot, root knot attacks many crops, but does not affect the cereals and grasses. It often proves quite destructive on summer legumes, especially those growing in light, sandy soils.

Root knot may be recognized by many large and small swellings involving the entire thickness of the root. These later decay and the plants have the general appearance of being affected by severe drouth before their premature death.

Root knot should not be confused with the beneficial root nodules. These are healthy in appearance, of more uniform size, and are loosely attached to the sides of the roots, not involving the whole thickness of the root.

Root knot is controlled by crop rotation in which susceptible summer crops are grown on infested land only once in three years. During the other two years the land may be used for any suitable resistant crop such as any grain or grass crop, peanuts, bur and Southern Giant bur clover or crotolaria. The cowpea varieties: Iron, Brabham, Monetta, Victor, Conch, and the soybean varieties: Laredo, Armredo, Biloxi, and O-too-tan are tolerant of the root knot disease and they can be grown successfully on infested soil, but they allow some development of the root knot nematode and for this reason they cannot be counted on to aid in starving out the nematodes in a rotation schedule.

MACROPHOMINA DRY ROT ("Charcoal Rot")

Macrophomina dry rot, commonly called "Charcoal rot," is a major disease of corn, sorghums, cowpeas, mungbeans, soybeans, and other leguminous crops. It is not important on the small grains.

Macrophomina dry rot kills plants during the last half of the summer growing season. Affected plants can easily be recognized by splitting the stem. The stem will be found hollowed out and dotted on the inside with many tiny black fungous spots as though pepper had been shaken about.

Macrophomina dry rot particularly affects plants that are not growing vigorously. Control depends mainly on practices that increase the vigor of the crop, such as observance of recommended planting dates, rates, depths, and methods, seed treatment to favor vigorous growth of seedlings, practices to improve the fertility of the soil, and use of the varieties of crops that have been shown to be well adapted and make the most vigorous growth in each locality.

Progress is being made in the development of dry rot resistant varieties of sorghum. The medium and later maturing sorgos, such as Atlas, Kansas Orange, African Millet (sourless), Sugar Drip, and Honey, and most of the kaffirs are more resistant than other sorghums. Other varieties and strains are showing resistance in tests at the Oklahoma Experiment Station.

SEED TREATMENT TO CONTROL DISEASES

Recommended Treatments

Until recently seed treatment of field crops was used only to control smut. Extensive tests have now shown that seed treatment has another value which is even more important. Seed treatment chemicals kill germs of disease that live from one year to the next on seed. These chemicals also kill germs and fungi of plant diseases in the soil around the sprouting seed and young seedlings. This produces better stands and healthier seedlings. When planting is followed by cold, wet weather, treated seed will often produce a stand where untreated seed is a complete failure.

Seed treatment costs only a few cents per acre and is recommended as a standard practice in the growing of all grain crops. It is insurance against surface seed-borne infection and unfavorable weather following planting.

Tests with the field legumes are not as extensive as those with the cereal crops, but have given encouraging results, particularly with the use of such disinfectants as Spergon and Arasan. These chemicals, if properly used, do not interfere with the action of root nodule bacteria.

Recommended Treatments

The table on page 18 lists the seed treatments recommended for various crops. These chemicals are to be applied according to directions on the containers; usually $\frac{1}{2}$ to 3 ounces of the chemical dust is well mixed with the seed. Seed may be treated any time up to 24 hours before planting. Overdoses must be avoided; seed may be injured if too much chemical is used.

POISON HAZARD. Seed treated with organic mercury dusts or copper carbonate is POISONOUS. It should be marked "POISON" and kept from livestock. The dust should be stored where there is no possibility of its being mixed with food. Ceresan should not be allowed to come in contact with bare skin, especially when moist.

SEED TREATERS

Any of the following may be used for applying protectant dust to field crops seed:

Minnesota Treater. (Homemade).—Used for all cereal and legume seed and all dusts. Treats about 1 bu. per minute.

CHEMICALS USED FOR SEED TREATMENT

*And the Crops for Which They Are Recommended by the
Respective Manufacturer.*

	Ceresan (2%)	New Im- proved	(5%) Seme- san Jr.	Seme- san	Arasan	Spargon	Bar- bak-C	Copper Carbo- nate	Fer- mate	Red (or yellow) Copper Oxide	Form- alde- hyde
Wheat		X*									
Oats		X*									X
Barley		X*									
Corn			X		X*	X*	X				
Flax		X			X	X					
Millet		X			X	X					
Rye		X			X	X					
Sorghum		X			X	X		X*			
Cowpeas				X	X*	X*			X		
Soy- beans	X			X	X*	X*			X		
Pea- nuts	X				X*	X*				X	
Cotton	X*	X*				X					

Vertical Barrel Gravity Treater. (Homemade).—Used particularly for treating wheat, sorghums, and legumes. Unsatisfactory for barley, oats, rye, or cotton seed, or for use with copper carbonate. Treats about 1 bu. per minute.

Revolving Barrel Treater. (Homemade).—For all seed and dusts. The only homemade treater that can also be used for cotton. Treats 1 to 2 bu. per 5 minutes. Laborious if large amounts of seed are to be treated, but very practical for small acreages where both cereals and cotton are grown. Also useful for inoculating legume seed.

Cement Mixers; Churns.—These may be adapted to seed treatment with a little ingenuity, the capacity and speed varying with the type of equipment. Suitable for all cereals and all dusts.

Commercial Treaters.—Several makes are available, with or without the added features of cleaning and grading seed. Suitable for operation by elevators or mills as a custom service for farmers, for operation as a community project, or for operation on a custom basis by a single farmer, Future Farmer, or 4-H Club member. Capacity 1 or more bu. per minute.

* Treatments of the crops with the chemicals thus marked are especially recommended in Oklahoma.

Plans for construction and instructions for operating any of the three types of homemade treaters are furnished free by the Bayer-Semesan Co., Wilmington, Delaware.

The practice of dusting seed grain by sprinkling the dust on a pile of grain in the wagon box or on the barn floor, and then shovelling over the pile with a grain scoop is frequently followed, but is not to be recommended in general, considering the low cost of homemade treaters (about \$3), the poison hazard of inhaling certain of the dusts, and the frequent failures from the "scoop method." It is entirely unsatisfactory with copper carbonate dust.

Formaldehyde Seed Treatment for Oats

More and more growers are turning from the formaldehyde treatment to Ceresan seed dusting because the latter is easier and is an advantage in securing better stands as well as in smut control. However, the following directions are included for those who prefer to use the formaldehyde method.

The formaldehyde may be applied in any one of three ways, known respectively as the dry treatment, the dip treatment, and the sprinkle treatment. In all three cases the same amount of formaldehyde is used; namely, one pint to fifty bushels of seed.

Dry Treatment.—For the dry treatment, mix 1 pint of commercial formaldehyde with 1 pint of water. Apply this mixture uniformly with a sprayer at the rate of 1 quart of the mixture to 50 bu. of seed as it leaves the grain spout or as it is being shoveled from one pile to another on a clean floor or canvas, or in a tight wagon box. Bin it or pile and cover with canvas, blankets, or disinfected sacks for 4 to 8 hours. Then sow immediately or run through a fanning mill or otherwise expose to air before storing for any length of time. If treated grain is stored in an elevator, it should be moved and aerated, preferably by running through a fanning mill, within 4 to 8 hours after treatment.

Dip Treatment.—For the formaldehyde dip treatment mix 1 pint of commercial formaldehyde with 40 gallons of water in a barrel or tank. For best results the temperature of the water should be about 60° to 70° F. Dip loosely filled burlap sacks in this solution until the grain is thoroughly wet. Drain and dry 2 hours or over night. Then sow immediately. If the sowing must be delayed, spread out the treated seed to dry and sow as soon as possible. Treated seed should not be allowed to freeze while it is damp or wet. If the grain is moist, increase the seeding rate about one-fourth.

Sprinkle Treatment.—For the formaldehyde sprinkle treatment mix 1 pint of commercial formaldehyde with 20 to 30 gallons of water at a temperature of 60° to 70° F., and, with a sprinkling can, sprinkle it uniformly on the 50 bushels of seed grain as it is being shoveled from one pile to another on a clean floor or canvas, or in a tight wagon box. Shovel until all the seed is uniformly moist. Pile and cover with canvas, blankets, or disinfected sacks for at least 4 hours, or overnight. Then sow immediately. If the sowing must be delayed, spread out the treated seed to dry and sow as soon as possible. Treated seed should not be allowed to freeze while it is damp or wet. If the grain is moist, increase the seeding rate about one-fourth.

Hot Water Treatment for Loose Smuts of Wheat and Barley

Loose smut of wheat and brown loose smut of barley are carried inside the seed and therefore cannot be controlled by seed-dusting. A hot water seed treatment must be used. The modified hot water treatment in general use requires presoaking the loosely sacked grain in cold water for 4 hours, a one minute dip in water at 120° and a 10 minute immersion in water at 129° for wheat or 13 minutes at 126° for barley. The grain is then cooled by dipping in cold water or is immediately spread out to dry without previous cooling. Complete drying requires about 6 hours in summer with full sunlight.

Ordinarily, hot water treatment is not recommended for all of the seed grain for the entire crop acreage. Instead treat only enough seed for 1/10 to 1/16 of the total grain acreage on the farm. With this treated seed plant a block big enough to produce seed for the entire acreage the following year. The treatment may be repeated at intervals of two or more years if sufficient smut blows in from neighboring fields to contaminate the crop from treated seed. It is recommended that hot-water treated seed be subsequently dusted with Ceresan to aid in securing a good stand.

There may be some loss in seed viability from the hot-water treatment, but if the treatment is done properly and the seed grain is in fairly good condition and relatively free of cracked or broken grains, this loss will be unimportant.

The greatest danger from the treatment lies in failure to dry the grain properly after treating. It need not be dried quickly if it is spread out thinly enough to prevent heating. Tests at the Oklahoma Agricultural Experiment Station show that grain may be soaked 12 hours before treating, treated,

then soaked another 12 hours before drying, without loss of more than 1% in viability. There is no serious danger from sprouting under these conditions. Wheat can be germinated until the sprout is one-half the length of the seed, then dried and the process repeated seven times without loss of more than 1% in viability.

The equipment for the hot water treatment varies with the size of the problem and the cooperation and ingenuity shown by those undertaking the treatment. For relatively small amounts of grain on single farms, a series of water barrels may be used, their temperature being regulated by addition of boiling water from time to time. It is much better, however, to undertake the treatment as a community project. This assures better control of the conditions of treatment, as the work can be done under the supervision of a county agent or vocational agriculture instructor. A community project also gives added loose smut protection since the number of disease spores carried by wind is decreased in proportion to the number of neighbors cooperating. Community action also makes it possible to utilize larger equipment, which is more efficient.

The type of equipment to be used in community hot water seed treatments depends on what is available. In all cases the essentials are the same: immersion of the loosely sacked wheat for 1 minute at 120 degrees and 10 minutes at 129 degrees, followed by quick cooling and drying.

Accurate control of time and temperature is much easier when the Oklahoma hot water seed grain treater is used. This machine was designed at the Oklahoma Experiment Station in 1939 and tested in several state communities in 1940 and 1941. It treats 500 bushels a day, and cost \$150 to build in 1939. It can be mounted on a trailer for portability. Information on the Oklahoma hot water seed treater can be obtained by writing: Plant Pathology Department, Oklahoma A. and M. College, Stillwater, Okla.

Because the hot water method takes more time and equipment than other types of seed treatment, farmers faced with the loose smut problem may prefer to secure new seed which is free from loose smut. This must be determined in the field producing the seed at the time the crop is blossoming. Unless a grower has seen the field at this time, it would be safer to buy certified seed. Fields containing any considerable amount of loose smut are not approved for certification in Oklahoma.

USE OF CERTIFIED SEED

Many field crop diseases are carried by the seed, therefore the use of certified seed is one of the foremost practices in avoiding disease problems. Certified seed comes from fields that have been inspected for disease and found relatively free. Use of certified seed is especially valuable in avoiding diseases that are seed borne, but cannot be recognized in the seed, such as loose smuts of wheat and barley, and mosaic disease of cowpeas and other field legumes.

The extra cost of certified seed is more than offset by its advantages. In addition to being relatively disease-free, it is pure as to variety, has good quality, and is free of noxious weeds.

Current lists of varieties and sources of certified seed can be obtained by writing: Oklahoma Crop Improvement Association, Oklahoma A. and M. College, Stillwater, Okla.

SOME USEFUL REFERENCES

The following publications are free to Oklahoma residents unless otherwise indicated. If your county agent does not have the publication you want, write to: *Agricultural Mailing Room, Oklahoma A. and M. College, Stillwater, Okla.*

"The Nature and Prevention of Plant Disease." 584 pages; price \$4.00. (Blakiston Company; Philadelphia.)

"Bacterial Wilt of *Alfalfa* and its Control." U. S. D. A. Circular 573.

"Diseases of Dent *Corn* in the United States." U. S. D. A. Circular 674.

"Protecting *Cotton* from Insects and Plant Diseases." Okla. Agri. Exp. Sta. Circular 196.

"*Cotton* Diseases and Methods of Control." U. S. D. A. Farmers' Bulletin 1745.

"*Ergot*." Okla. Agr. Exp. Sta. Mimeographed Circular M-55.

"Grow Disease Resistant *Oats*." U. S. D. A. Farmers' Bulletin 1941.

"Disease-Resistant and Hardy *Oats* for the South." U. S. D. A. Farmers' Bulletin 1947.

"Seed Treatment for *Peanuts*." Okla. Ext. OP-77.

"*Sorghum* Diseases and Their Control." U. S. D. A. Farmers' Bulletin 1959.

"*Soybean* Diseases and Their Control." U. S. D. A. Farmers' Bulletin 1937.

"A Brief Summary of *Wheat* Improvement Work in Oklahoma." Okla. Agr. Exp. Sta. Mimeographed Circular M-100.

"Control of *Wheat* Smuts in Oklahoma." Okla. Agr. Exp. Sta. Mimeographed Circular M-34.

"*Cotton Root Rot* or *Texas Root Rot*." Okla. Agr. Exp. Sta. Mimeographed Circular M-53.

"*Root Knot*." Okla. Agr. Exp. Sta. Mimeographed Circular M-44.

"*Root-knot*, Its Cause and Control." U. S. D. A. Farmers' Bulletin 1345.

"Treat Seed Grain." U. S. D. A. Miscellaneous Publication 219.

